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# WHEELED WORK MACHINE WITH MODULAR VENTILATION SYSTEM

## BACKGROUND OF THE INVENTION

The present invention relates to power machinery. More particularly, the present invention relates to a modular ventilation system for a wheeled work machine.

Although compact tractors, skid steer loaders and other types of wheeled work machines have enjoyed great success and are used throughout the world in a number of different applications, these machines are not well suited for all work environments. For example, compact tractors, while useful in some applications, frequently have a number of characteristics, which limit their usefulness in some applications. Typically, compact tractors have poor visibility to the front (i.e., toward the bucket). Compact tractors also typically have limited hydraulic systems for operation of attachments, and the attachments are frequently behind the operator, forcing the operator to turn around to see them. Further, for the operator of the compact tractor, entry/egress is often awkward or difficult and usually the tractor only provides seating for a single person. Also, compact tractors lack a cargo area, which severely limits their usefulness in many applications. Other common limitations of compact tractors include a relative

lack of stability and the rough ride provided by many compact tractor designs.

Utility carts are another type of wheeled work machine, which have a number of characteristics that limit their usefulness in some applications. For example, utility carts do not have a loader option, and typically have limited or no attachment capability. Also, utility carts generally have limited, if any, onboard hydraulic systems for the operation of hydraulic attachments. Other typical characteristics of utility carts, which limit the applications in which they can be used, include a relatively large turning diameter and a limited ability to carry cargo. Utility carts are frequently low on power needed to pull equipment or carry cargo.

In many applications, a small turning diameter would be a beneficial feature of a wheeled work machine. However, many wheeled work machines, if not most, do not have small turning diameters. Thus, to change direction of travel, these machines need to stop, change direction, reorient the machine, and proceed in the intended direction. Typically, machines with front steerable wheels (for example, tractors and most utility vehicles) have to maintain a short wheelbase in order to maintain a small turning diameter, as wheelbase and turning diameter are inversely proportional. However, a short wheelbase has a negative effect by decreasing

stability, lift capacity, operator area, cargo area, etc.

Most compact tractors maintain a relatively small turning diameter by turning the front wheels extremely sharply and generally by having a shorter wheelbase. Turning the wheels excessively sharp can be damaging to sensitive grounds such as lawns and turf areas. Further, even with a short wheelbase (and the disadvantages which result), the relatively small turning diameter of compact tractors may not be small enough for some applications. Most utility carts have a large turning diameter, which is unacceptable for many applications, due to the fact that they cannot turn the wheels as sharply as a typical tractor and that they require a longer wheelbase to place the operator seating, engine, cargo area, etc. A wheeled work machine which provides a small turning diameter without the disadvantages associated with the short wheelbase of tractors, would be a significant improvement in wheeled work machine applications.

Generally, wheeled work machines such as compact tractors, utility carts, and other types have numerous limitations, which prevent them from being suited for some applications. Some of these limitations are discussed above with reference to compact tractors and utility vehicles, but they may apply to other types of work machines as well. In addition to turning diameter characteristics, a

common limitation in many wheeled work machines is a general inability to carry more than one person to a work site. Other limitations include an inability to carry cargo, poor visibility, lack of attachments such as a bucket or loader, low power, and instability, to name a few.

Skid steer loaders have proven to be highly useful in many applications. Skid steer loaders have features, which are often highly beneficial for certain work environments. For example, skid steer loaders can support a wide variety of work tools and attachments. Skid steer loaders can also be turned very sharply. Numerous other features of skid steer loaders provide these machines with highly advantageous capabilities. Although skid steer loaders have enjoyed great success and are used throughout the world in a number of different applications, the skid steer loader is not well suited for all work environments.

Other problems present themselves when developing HVAC units for work machines as well. A requirement of such systems is a source of fresh air. Fresh air is drawn into the operator's compartment to pressurize it. This reduces the likelihood that dust or other particles will enter the cab through small openings. A logical choice as a source of fresh air is where the air is cleanest, which may typically be the forward, exterior portion of the machine. However, front attachments can render the environment

at the front of the machine quite dirty. In addition, should multiple openings in the cab be provided to receive fresh air, each opening creates a potential leak point for dust and dirt to enter the cab.

Still other problems which must be addressed include airflow and filtering. Adequate airflow and recirculation must be provided in the cab. Further, any filtering that is done must be done at a location which makes servicing of the air filters easy and quick.

In addition, in prior power machines, heating, ventilation and air conditioning (HVAC) systems are integral with a remainder of the machine electronics and mechanical configuration. Therefore, to add a HVAC system to such a power machine has required fairly lengthy mechanical operation. This made it quite difficult to retrofit machines with HVAC units or to remove HVAC systems from machines.

## SUMMARY OF THE INVENTION

A modular HVAC unit is disposable within a power machine. The modular HVAC unit can illustratively be placed in the operator compartment and may require only simple electrical, fluid and air duct connections.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a wheeled work machine of the present invention.

Fig. 2 is a side elevational view of the wheeled work machine with portions removed.

Fig. 3 is a perspective view of the wheeled work machine with portions removed.

Fig. 4 is a side elevational view of the wheeled work machine with portions shown with dashed lines.

Fig. 5 is a bottom plan view of the wheeled work machine.

Fig. 6 is a side elevational view of a lift arm assembly.

Fig. 7 is a rear elevational view of the lift arm assembly.

Fig. 8 is a front elevational view of the lift arm assembly.

Fig. 9 is a perspective view of a frame assembly.

Fig. 10 is a bottom plan view of a frame assembly.

Fig. 11 is an isometric view of a portion of the operator compartment of a wheeled work machine with one embodiment of a modular HVAC unit mounted therein.

Fig. 12A is a right side view of the portion of the operator compartment shown in Fig. 11.

Fig. 12B is a left side view of the portion of the operator compartment shown in Fig. 11.

Fig. 13 is a top isometric view of a modular HVAC unit in accordance with one embodiment of the present invention.

Fig. 13A is a partial sectional view taken along lines A-A in Fig. 13.

Fig. 14 is a rear view of a modular HVAC unit in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is directed to a modular heating, ventilating and air conditioning (HVAC) unit mountable within a wheeled work machine. One example of a wheeled work machine is described herein. It should be noted, however, that this is but one example of a wheeled work machine in which the HVAC unit can be mounted. The unit can be mounted in other machines as well.

An exemplary embodiment of a wheeled work machine 10 of the present invention is illustrated in Figs. 1, 2 and 3. The wheeled work machine 10 includes a rigid frame assembly 12 having a support 14 with a boom pivot 16. A front wheel assembly 18 is joined to the frame assembly 12 proximate the support 14. Similarly, a rear wheel assembly 20 is joined to the frame assembly 12 at an end thereof remote from the support 14.

The wheeled work machine 10 further includes an engine 24, an operator platform 26 (herein embodied as a seat) and a cargo support 28.

Location of these elements in combination with the support 14 for the boom pivot 16 provides a unique, multi-purpose machine that is compact and

usable in a number of different applications. In particular, the operator platform 26 is located behind the support 14 and between the boom pivot 16 and the engine 24. In addition, the cargo support 28, which is also supported by the frame assembly 12, is located behind the operator platform 26 and, in one embodiment, over at least a portion of the engine 24. In the embodiment illustrated, the engine 24 is coupled to a hydraulic pump 30, which in turn, is coupled to a lift cylinder 32. Under selective control by the operator, the lift cylinder 32 can be used to tilt a lift arm 34 that is pivotally coupled at the boom pivot 16. In a manner discussed below, various tools can be attached to the lift arm 34 to perform various work functions at a position convenient for forward viewing by the operator sitting in operator platform 26. For instance, as illustrated, a bucket 36 can be coupled to a remote end 49 of the lift arm 34 and used to scoop or lift various types of materials. As illustrated and discussed below, a tilt cylinder 38 can also be coupled between the lift arm 34 and the bucket 36, which allows the bucket 36 to be pivoted relative to the lift arm 34. It should be noted however that the bucket 36 is but one exemplary tool that can be used with the wheeled work machine 10. The wheeled work machine 10 can include a single lift arm or boom 34 pivotally joined to the boom pivot 16. Use of a single lift arm 34 provides a stable, strong lifting

device, but also minimizes obstruction to the remote end of the lift arm 34 as viewed by the operator sitting in operator platform 26. Nevertheless, although illustrated as a single lift arm 34, those skilled in the art can appreciate that additional lift arms can be used, for instance, in a side-by-side relationship from the support or supports 14 disposed in front of the operator platform 26.

As illustrated, the lift arm 34 extends between a line between wheels of the front wheel assembly 18. In one embodiment, a minimum angle 39 formed between the boom pivot 16 and a second boom pivot 42 typically provided at a remote end of the lift arm 34 and a normal reference line 44 from the boom pivot 16 to a level ground surface is in the range of 20 to 35 degrees and in a further embodiment in the range of 22-28 degrees.

Using a rigid lift arm 34 between pivots 16 and 42 enables the bucket 36 to move forwardly during lifting from the initial angle 39 described above. The forward movement of the bucket 36 allows a less-experienced operator to easily fill the bucket 36 without requiring the wheeled work machine 10 to move forward during lifting. Due to the path taken by the bucket 36, the bucket 36 is filled during, approximately, the first 65 degrees of travel. Although many forms of loaders have the capability to raise a loaded bucket, many do not have the required traction or power to push the bucket completely into

a pile of heavy material. Likewise, because many buckets lift primarily vertically, due to the long extension of the booms or lifting arms, many machines do not have the ability to lift a full bucket through the material that is above the bucket in view that that bucket was driven into the pile. In contrast, the large forward component of bucket movement during lifting enables the bucket 36 to be easily filled with rotation of the lift arm 34. In one embodiment, the lift arm 34 pivots through an arc of 102 degrees from its initial starting position. In this manner, once the bucket 36 is filled, the bucket 36 moves away from the pile of material. The use of a single boom support 14 and a single lift arm 34 is particularly beneficial because this construction enables a compact assembly of the work machine 10 and also provides excellent viewing of the remote end of the lift arm 34 for the operator sitting in the operator platform 26.

In a preferred embodiment, the height of the pivot 16 with respect to a level ground surface is in the range of 48 to 54 inches, for example, 50.94 when angle 39 is 27.5°. Other dimensions include the position of pivot 42 with respect to pivot 16 (55 to 49 inches, preferably 51.83 when angle 39 is 27.5°) and the height of pivot 42 above the ground (2 to 8 inches, preferably 5 inches when angle 39 is 27.5°). Similarly, the position of pivot 48 with respect to pivot 16 is in the range of 42.5

to 48.5 inches, preferably 45.5 when angle 39 is 27.5°, and the height of pivot 48 above the ground is in the range of 9 to 15 inches, preferably 12 when angle 39 is 27.5°. Likewise the position of the lift cylinder connection (pivot 47) to lift arm 34 with respect to pivot 16 is 13 to 19 inches, preferably 16 when angle 39 is 27.5°, while the length of the lift arm 34 (from pivot 16 to pivot 42) is also 49 to 55 inches, preferably 51.83 when angle 39 is 27.5°.

As discussed above, the lift cylinder 32 is operably coupled between the frame 12 and the lift arm 34 to pivot the lift arm 34. In a further embodiment, the remote end 49 (Fig. 6) of the lift arm is joined, for example, pivotally, to the frame assembly 12 between the wheel assemblies 18 and 20 to provide a compact assembly. In this manner, the front wheel assembly 18 is disposed between the lift arm 34 and the lift cylinder 32. Use of a single lift cylinder 32 in the center of the wheeled work machine 10 also minimizes any damage thereto.

In the embodiment illustrated, a quick attachment interface member or assembly 50 is provided at the remote end of the lift arm 34 forward of the operator platform 26, which is a far more convenient position of the tool at the end of the lift arm 34. The quick attachment interface 50 has been utilized extensively by Bobcat Company and sold under the trade name BOBTACH. The interface assembly 50 allows quick attachment of various work tools such

as buckets, grapples, brooms, augers or the like. In this manner, by including the interface 50, the work machine 10 can readily accept and use all of the various types of work tools currently in use or developed in the future.

Referring to Figs. 6, 7 and 8, the interface 50 includes an attachment plate 52 pivotally attached to the second pivot 42. The tilting of the attachment plate 52 is controlled by the tilt cylinder 38, which is operably coupled between the lift arm 34 and the attachment plate 52. In the embodiment illustrated, a bracket 56 is provided with a pivot 58 to which an end of the tilt cylinder 38 is coupled. A second end 54 of the tilt cylinder 38 is operably coupled to the interface 50, and in the embodiment illustrated, through a link 60 that is pivotally coupled to the attachment plate 52. A standoff support 64 is also pivotally coupled to the lift arm 34 and to a common pivotal connection between the tilt cylinder 38 and the link 60.

Typically, the attachment plate 52 includes a lip 70 that will fit under a flange on an attachment or work tool such as the bucket 36. As is well known, apertures provided on the work tool will align with apertures of the attachment plate 52, or at least sliding wedges 74 provided on the attachment plate 52. The wedges 74 move linearly on the attachment plate 52. Typically, each of the wedges 74 have a tapered wedge end to aid in pushing the wedge

into the desired aperture on the attachment plate 52 or work tool when it is in position to be mounted. A spring 78 joins each of the wedges 74 to a corresponding lever 80 that is pivotally connected to the attachment plate 52. The arrangement is conventional and the levers 80 and spring 78 will load each corresponding wedge 74 downward to lock the wedge 74 as well as upward in an unlocked position. An actuator end of each of the levers 80 carry pivot pins 77 for the springs 78. Handles are provided on each of the levers 80 in order to allow manual operation. A power actuator such as disclosed in U.S. Patent 5,562,397 can also be provided, if desired.

Some work tools or attachments couplable to the interface 50 can be powered or operated hydraulically. The work machine 10 can include hydraulic couplings that are fluidly coupled to the pump 30 through suitable control valves or the like. The couplings can be provided at or near the interface 50 and/or proximate the support 14, for example, on the work machine body at 81 (Fig. 1). Likewise, if desired, hydraulic couplings can be provided at the rear of the work machine proximate the cargo support 28.

Referring to Figs. 3 and 5, movement of the work machine 10 is provided by wheels 94 mounted on each of the wheel assemblies 18 and 20. Either or both of the wheel assemblies 18 and 20 can be powered by the engine 24, for example, by mechanical drive

shafts, chains, belts or the like. In the embodiment illustrated, hydraulic drive motors are mounted to the housing assemblies 84, which in turn, drive the wheels 94. The drive housing assemblies 84 can be independent, i.e., one for any chosen wheel 94, or as illustrated, have opposed output shafts 88 to drive a pair of wheels 94.

The drive housing assemblies 84 can include gear reduction, wet disk brake, differential, differential lock and the output shafts 88. In one embodiment as illustrated, pivotal couplings 90 are provided at the ends of the drive housing assemblies 84 and are coupled to hub assemblies of the wheels 94 to allow the associated wheels 94 to pivot. Tie rods 94 coupled to a suitable steering mechanism having a steering wheel 98 (Fig. 1) proximate the operator platform 26 can control pivotal motion of the wheels 94. In the embodiment illustrated, each of the wheel assemblies 18 and 20 allow the corresponding wheels 94 to be pivoted providing for all-wheel steering capability resulting in a small turning diameter. Nevertheless, in an alternative embodiment, the steering mechanism can be coupled to only the front wheel assembly 18, or to only the rear assembly 20.

The steering mechanism for the front and/or rear wheels 94 can take any number of forms such as a mechanical linkage between the steering wheel 98 and the steerable wheels of the front wheel assembly 18 and/or rear wheel assembly 20. In the embodiment

illustrated, the wheels are steered using hydraulic cylinders mounted to the drive housings. There can be a steering cylinder for each steerable wheel, or pairs of wheels can be steered with a single cylinder and a tie rod connection. The steering wheel 98 can be coupled to a steering sector to direct pressurized hydraulic fluid to the appropriate steering cylinders thus obtaining steering of the desired wheels. The steering modes can illustratively include front wheel steer, rear wheel steer, coordinated steer (in which the front and rear wheels are steered in pairs in opposite directions to implement tighter turns) and crab steer (in which the front rear wheels are again steered in pairs but in the same direction). A control valve can be further used in the hydraulic circuit of the rear wheels, wherein the control valve receives an input related to the type of steering desired for the rear wheels, e.g. coordinated or crab steer, and properly directs pressurized to the steering actuator based on the desired mode of steering. Allowing the work machine 10 to steer all of the wheels 94 significantly minimizes damage to the ground surface, which can occur during travel to the work site or operation of the work machine 10 at the job site.

In one embodiment, multiple seat positions can be provided through individual seats, as illustrated, or a common bench seat. Configured in this manner, the work machine 10 allows side-by-side

seating positions for the transportation of two or more individuals to the job site. It should be further noted that the operator platform 26 is disposed on the frame assembly 12 between the wheel assemblies 18 and 20 so as to provide a stable platform. In the embodiment illustrated, the operator platform 26 forms part of an operator station 100 that can include a canopy 102. An exemplary construction of side panels for the operator station 100 is described in co-pending application "Side Panel Assembly for Wheeled Work Machine", Serial No. ______, filed _________ . A windshield 104, back window 106 and doors (not shown) can also be provided in order to enclose the operator station 100, if desired.

An instrument cluster and dash 110 is generally disposed in front of the operator platform 26 and behind the boom pivot 16 and includes gauges, controls and the like for operation of the work machine 10. The instrument cluster and dash 110 is also disposed at a level such that an upper surface thereof allows an operator of height in the range of a female in the fifth percentile to a male in the ninety-fifth percentile to view an end of the lift arm 34 remote from the boom pivot 16.

The cargo support 28 located behind the operator platform 26 and supported by the frame assembly 12 allows the transportation of tools and/or other material to the job site. Although exemplified

herein as a cargo box (open or enclosed), which can also tilt through a suitable lift cylinder and hinge coupling the cargo box to the frame assembly 12, which has a floor 120 and side walls 122 (with or without tailgates or side gates), the cargo support 28 can include other forms of containers or platforms. For instance, the cargo support can also include a sprayer having a suitable tank for containing liquid, a hopper such as for spreading sand, or a plurality of tool boxes to name a few.

Referring Figs. 2 and 5, engine 24 is generally located behind operator platform 26 and below cargo support 28. In one embodiment, a transverse engine is supported by the frame assembly 12 at this location. The transverse engine 24 includes a crank shaft indicated by dashed line 138 oriented transversely with respect to a longitudinal axis (front to back) of the work machine 10. Although other orientations of engine 24 can be used, the transverse engine provides a compact assembly that can also be easily serviced.

Also shown in Figs. 2, 4, and 5 is a radiator assembly 145 for cooling engine 24. Radiator assembly 145 is supported at least partially beneath cargo support 28 by longitudinal frame members 130. In one embodiment, longitudinal frame members 130 are C-channel frame members (see for example FIG. 9). In these embodiments, radiator assembly 145 can be supported via positioning

between, and within the C-channels of, frame members 130.

In the embodiment illustrated, radiator assembly 145 is supported by longitudinal frame members 130 behind the rear axle. This is shown in the Figs. by placement of the radiator assembly behind rear wheel 94 or suspension assembly 180.

Radiator assembly 145 includes a radiator 151 and optionally one or more air flow generation device 153 such as a fan or other blower for removing heat energy by moving air past radiator 151. In the illustrated embodiments, radiator assembly 145 includes dual fans or air flow generation devices 153, with one positioned on top of radiator 151, and one positioned below radiator 151. In other embodiments, radiator assembly 145 and air flow generation devices 153 can be positioned elsewhere. Radiator assembly 145 also includes hoses 146 which carry coolant between engine 24 and radiator 151. Also, radiator assembly can include other features, for example an airflow redirecting structure or mechanism which redirects airflow from fans 153 toward the rear of the wheeled work machine in order to minimize dust in the area of operator station 100.

Radiator 151 is supported relative to longitudinal frame members 130 and the ground in a "flat" position in order to further facilitate the compact design of wheeled work machine 10. In other words, radiator 145 has a vertical dimension relative

to the ground which is less than its longitudinal dimensions indicated generally at 147 and 148 in Figs. 2, 4 and 5. Generally, radiator 151 is oriented with its longitudinal dimensions substantially parallel to the ground to give it a low profile. However, radiator 151 can also be oriented at slight angles relative to the ground, for example up to about 45° or less to create the exhaust. Including a flat radiator 151 for cooling of engine 24 allows the radiator to be supported by longitudinal frame members 130 beneath cargo support 28. In addition to saving space and facilitating a compact and stable wheeled work machine configuration, utilization of a flat radiator assembly 145 placed in this position can also serve to protect the radiator from damage relative to other potential locations on the wheeled work machine.

Referring now to Figs. 5, 9 and 10, the frame assembly 12 is a "rigid" frame assembly wherein no frame articulation is provided between the front wheel assembly 18 and the rear assembly 20. In the embodiment illustrated, the frame assembly 12 includes longitudinal frame members 130 extending from the rear wheel assembly 20 toward the front wheel assembly 18. Generally the frame assembly 12 includes a cargo support portion 132, a middle portion 134 and a front or boom support portion 136. The portions 132, 134, 136 can be attached together as illustrated in FIG. 9 wherein cargo support

portion 132 and middle portion 134 are generally attached and defined at connection 135, wherein longitudinal members 130 extend from front to back and are defined by longitudinal sections forming portions 132, 134 and 136. Alternatively, portions 132, 134, 136 may be integral. The cargo support portion 132 and the boom support portion 136 are not as wide as the middle portion 134. The narrower width of the cargo support portion 132 and the front or boom support portion 136 allows for increased pivoting of the wheels 94 for steering of either the front wheel assembly 18 and/or the rear wheel assembly 20. In contrast, the wider transverse width of the middle portion 134 allows accommodation of the transverse oriented engine 24 and provides a stable mount for the operator station 100.

In the embodiment illustrated, the front or boom support portion 136 is particularly strengthened so as to inhibit bending or twisting due to loads carried by the lift arm 34 such as with bucket 36. The front or boom support portion 136 can therefore include a plurality of transverse members 139extending between the longitudinal members 130, or as illustrated herein, one or more plate members 140 to which the lift cylinder 32 is pivotally connected. An elongated aperture 142 can be provided in an upper plate member 140 as illustrated in Fig. 9 to accommodate pivoting motion of the lift cylinder 32 during operation thereof. Additional support and

resistance against twist to the frame assembly 12 can result from a torque tube 143 being provided at or near the connection 135 of middle portion 134 and cargo support portion 132. As described below, transverse members 177, 179 provide support for rear suspension assembly 20.

The support 14 is joined to ends of the longitudinal 130 members and to the transverse ties or the plate members 140 as illustrated in Figs. 9 and 10. Generally, the support 14 includes side plates 150, an upper back plate 152 and a lower front plate 154, both of which connect the side plates 150 together. An inclined connecting plate 155 can also be provided with an aperture 156 to allow the lift cylinder 34 to extend therethrough. Extending supports 158 can also be provided for support of the operation station 100 on elastomeric isolators, if desired. The operator station 100 can be supported on two additional elastomeric isolators at the rear, if desired. In this manner, the operator station 100 increases the strength of the boom support 14. It should be noted that although direct support for the operator station 100 is provided at supports 158 and at the rear of the frame 20, the operator platform 26 is nevertheless supported by the frame and disposed between the boom support 14 and the cargo support 28. It should be understood that the location of the mounts for operator station 100 and thus the operator platform 26 can occur anywhere on the frame 20.

Referring to Fig. 2, the longitudinal frame members 130 can extend below the operator station 100, and in particular, at a level below an upper surface 160 of the floor panel of the operator station 100 in order to allow easy entry and egress from the operator station 100. As further illustrated, each of the longitudinal frame members 130 can extend upwardly through the middle portion 134 and then over the rear drive assembly 20. In this manner, the operator station 100 and operator platform 26 can be lower so as to allow easy entry into and egress from the operator station 100 and provide a stable platform. Similarly, the front or boom support portion 136 extends at substantially the same level as the portion of the longitudinal frame members 130 below the upper surface 160 of the floor panel. As illustrated, the thickness of the longitudinal frame members 130 for the inclined portions of the middle portion 134 is greater than the thickness of the longitudinal members 130 in the cargo support portion 132 and front or boom support portion 136 so as to concentrate section modulus where needed in order to inhibit bending associating with heavy loads on the remote end of the lift arm 34. Alternatively, front portion 136 and middle portion 134 can be of increased height to concentrate section modulus where needed. Likewise, the height of the longitudinal frame members 130 in the cargo support portion 132 can be similar to the front

portion 136 with only the inclined portions of middle portion 134 being of greater height. Although the frame assembly 12 has unique physical characteristics for the reasons discussed above, these physical characteristics can be included in numerous aesthetic designs.

In spite of the rigid frame assembly 12 described above, which is well suited for handling loading due to the lift arm 34, each of the wheel assemblies 18 and 20 can further include suspension assemblies allowing the smooth transportation of workers and materials to the job site. Referring to Figs. 4 and 14, an exemplary suspension assembly 180 for the rear wheel assembly 20 can include a leaf spring or springs 182 connected at remote ends thereof to each of the longitudinal frame members 130. Opposed ends of the rear wheel assembly 20 are joined to a center portion of the leaf spring or springs 182. Leaf spring 182 is supported by members 177, 179 attached to the frame assembly 12. In the embodiment illustrated in Figs. 9 and 14, member 177 is a transverse bracket extending across the cargo support portion 132, while member 179 is a bracket mounted to torque tube 143. Other suitable suspension elements that can be used include coiled springs, and the like, operably coupled between the rear wheel assembly 20 and the frame members 130.

If further desired, an overtravel assembly 184 can be provided and operable when substantial

loads are carried by the work machine 10, for example, on the cargo support 28 when full deflection of the leaf spring or springs 182 is obtained. The overtravel assembly 184 can have a second spring rate stiffer than that of the leaf spring or springs 182 and can be operable only when a selected amount of deflection has been obtained. For instance, the second spring assembly 184 can comprise compressive, elastomeric stops that selectively engage portions of the rear drive assembly 20.

Schematically illustrated in Fig. 4, a suspension assembly 190 for each side of the front assembly 18 can include fluidic dampers 192 joined between the front wheel assembly 18 and the frame assembly 12. Coiled springs can also be provided. The fluidic damper 192 can include fluid chambers formed on opposite sides of a center piston in a suitable cylinder housing 196. Generally, the center piston or piston rod 194 is coupled to one of the front wheel assembly 18 or frame assembly 12, while the cylinder housing 196 is coupled to the other. During transportation to the job site, control valves such as check valves and/or pilot valves can be operated so as to allow fluid flow between the opposed fluidic chambers, wherein the fluid flow is restricted so as to provide damping. However, when it is desired to perform work using the lift arm 34, for example by picking up material with the bucket 36, the control valves for each of the suspension assemblies 198 for

the front wheels 94 can be operated so as to substantially inhibit or prevent fluid flow in order to substantially hold the center piston in a substantially fixed position relative to the cylinder housing 196. In this manner, the suspension assemblies 190 are "locked" in order to prevent, or at least substantially inhibit, relative motion between the front wheel assembly 18 and the frame assembly 12. If desired, similar lockable suspension assemblies can also be provided between the frame assembly 12 and the rear wheel assembly 20.

Fig. 11 is an isometric view of a portion of the operator compartment 100 illustrated in the above Figures. Fig. 11 illustrates seat mount or seat pan 26, dash 101 and the floor of the operator compartment. Fig. 11 does not show a steering wheel, for the sake of clarity. However, it will be understood that the steering wheel may illustratively be positioned on the left hand portion of operating compartment 100 as shown in earlier Figures.

Fig. 11 also shows one embodiment of a modular HVAC unit 200 disposed within operating compartment 100. It should be noted, of course, that the appearance of HVAC unit 200 may be changed (such as to provide a smoother, rounded look), as desired, without changing its functionality. HVAC unit 200 illustratively includes a set of user controls 202, input vents 204a, b and c (only vent 204a is shown in Fig. 11), and an output opening 206. Modular HVAC

unit 200 can illustratively be simply dropped into place within operating compartment 100 and secured therein by bolts, screws or other mechanisms providing a fixed or removable connection. It should be noted that controls 202 can be integrated into dash 101 or otherwise located remotely from HVAC unit 200,so long as they are operably connected thereto.

Similarly, HVAC unit 200 can be a conventional electrically powered unit thus having a simple electrical harness or other electrical connector which can be easily connected to the electrical system of work machine 10 to receive power therefrom.

In operation, the operator manipulates controls 202 to control the temperature and fan speed of HVAC unit 200. Air enters HVAC unit 200 through intake recirculation vents 204aand 204b and fresh air intake vent 204c (only vent 204a is shown in Fig. 11, the others are shown in subsequent figures) as illustrated by arrows 205. The air travels through the appropriate conditioning mechanisms and exits HVAC unit 200 through exit opening 206. In one illustrative embodiment, the air enters pre-existing duct work in dash 101 and exits vents located on the dash such that the conditioned air can be directed toward the operators in the operating compartment, as indicated by arrows 208 and 210. The duct work in dash 101 may, itself, be modular and only provided when desired.

Of course, it should also be noted that HVAC unit 200 can have exit vents itself. In that embodiment, there need not be any pre-existing duct work in the dash of machine 10. Instead, the conditioned air simply exits the exit vents on the HVAC unit 200 itself which are directed in the general direction of the operators or occupants of machine 10.

It should also be noted that the dash of machine 10 can be provided with any desirable duct work. For example, the duct work can simply lead to vents directed generally toward the occupants of machine 10 or it can lead to vents which are directed toward a windshield of the operator compartment, or it can have both vents selectable by a moveable damper within the duct manifold. The moveable damper, of course, can illustratively be positioned by an occupant of machine 10 who is residing in the operator compartment. A plenum may be provided which mates with opening 206 in unit 200 to receive conditioned air from unit 200.

Fig. 12A is a right hand view of the HVAC unit 200 and operator compartment shown in Fig. 11. Fig. 12A illustrates exit opening 206 as well as pre-existing duct work 212, which is simply shown diagrammatically in Fig. 12A. The duct work, of course, can take any predetermined shape.

Fig. 12A further illustrates, diagrammatically, fresh air intake vent 204c. In the

embodiment shown, recirculation vents 204a and 204b recirculate air from within the operator's compartment while fresh air intake vent 204c receives air from outside the operator's compartment. In Fig. 12A, fresh air vent 204c is located under seat pan 26. It is believed this will generally be clean air. However, the fresh air intake vent 204c can also receive air from other sources, such as through a screened opening in the cab, or above the cargo area to the rear of the cab, and ducted to the intake vent 204c. A fresh air pre-filter can also be incorporated in the ducting either up stream or down stream of vent 204c.

With the vents located as shown and discussed, enhanced air circulation is obtained within the cab. With the intake vents near the foot area of the cab, and the outlet vents in the dash, the air moves in a generally circuitous path, out the outlet vents toward the operator, down to the floor and back in the recirculation vents. The air is mixed with a desired percentage of fresh air from fresh air intake vent 204c, filtered and again output through the outlet opening 206.

Fig. 12B is a left hand side view of HVAC unit 200 shown in Figs. 11 and 12A. Fig. 12B also shows pre-existing duct work 212 diagrammatically. In addition, Fig. 12B illustrates that inlet vents 204a, 204b and 204c can take any desired shape, so long as they are sufficient to allow a desired volume

of air to enter HVAC unit 200 to accommodate maximum fan speed. Fig. 12B further illustrates that, in one illustrative embodiment, HVAC unit 200 is simply affixed to the generally vertical wall 416 of the seat mount. Of course, HVAC unit 200 could also be affixed to the floor of the operator compartment, and/or to fire wall 216 by any suitable device, such as screws, bolts, friction fitting flanges, etc.

Figs. 12A and 12B also show that the forward and bottom walls of HVAC unit 200 illustratively conform to the inner conformation (floor and fire wall) of the operating compartment of machine 10. This makes it extremely easy to mount HVAC unit 200 thereto.

Fig. 13 is an isometric view taken generally from a top portion of HVAC unit 200. Fig. 13 shows a portion of fan 230 disposed on the interior of the housing of HVAC unit 200. Fig. 13 also shows, in greater detail, controls 202. In one illustrative embodiment, controls 202 include a fan speed control 232, an air temperature control 234, and on/off switch 236. In an illustrative embodiment, rotation of fan speed control 232 to various positions causes the fan speed to change, while rotation of air temperature control 234 causes the temperature of the air exiting exit opening 206 to change.

Of course, controls 202 can include any other or different controls, such as a heater on/off

button, and air conditioner on/off button, slideable fan and temperature controls, etc. Also, as mentioned above, the controls can be located remotely from HVAC unit 200. Fig. 13 also shows filter access 207 in HVAC unit 200. Access 207 is illustratively a no-tools opening for servicing a filter located therein.

Figs. 13A shows access 207 in greater detail. Access 207 is formed by a hole 209 in the wall of unit 200. Hole 209 is sized to receive an air filter 211 which is located in the air flow path within unit 200. Access 207 also has a door 213 with a panel portion 215 and a simulated hinge portion 217. Hinge portion 217 is illustratively formed of a bent section of door 213 located within a slot 219 in the wall of unit 200. Panel portion 215 is illustratively releasably secured to the wall of the unit 200 using any suitable mechanism, such as a latch or hook and loop fabric, etc...221.

Fig. 14 is another view of HVAC unit 200 taken from the rearward facing side of HVAC unit 200 when it is mounted in the operator compartment of machine 10. Similar items are similarly numbered to those shown in previous Figures. Fig. 14 shows that, in one illustrative embodiment, HVAC unit 200 includes a compressible gasket 240. Gasket 240 can illustratively be made of a thin sheet of closed cell foam. The gasket 240 compresses between HVAC unit 200 and the vertical wall of the seat mount as the fasteners (e.g. screws or bolts_) are tightened,

creating an airtight seal and serves an insulation between unit 200 and the mounting surface. Gasket 240 also reduces noise from vibration of unit 200 against its mounting surface.

Fig. 14 also illustrates one exemplary set of air conditioning connectors 242. The connectors 242 deliver compressed refrigerant to the expansion valve in unit 200. Of course, unit 200 also illustratively includes heater connections and a wire harness connector, which are not shown here.

It can thus be seen that the present invention is directed to an advantageous modular HVAC unit for a work machine that addresses one or more drawbacks associated with prior devices.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.